available for the exact observation. The secular variations of pressure are accompanied by a flow of air from one hemisphere to the other and back again. The diurnal variation of the barometer still remains a difficult problem, but there is some evidence of its being a wave swinging through the air in forced vibrations, such as Lord Kelvin suggested. Hutton's theory of condensation of vapors mixed at different temperatures is applicable to the formation of clouds but not to rainfall. A reliable self-registering psychrometer is greatly needed in practical meteorology. The measures of rainfall ought to be reduced to a scientific scale in all cases.

The Espy–Köppen theory of the diurnal variation of the wind velocity in different strata is satisfactory. The relative amount of solar radiation absorbed in the upper and the lower atmosphere is an important problem only partially worked out. The deflecting and centrifugal forces expend no energy on the movement of masses of air, but change only the direction of their motion and not the velocity. The vertical thickness of the land and sea breezes, the mountain and valley breezes, and the monsoon and trade winds ought to be carefully determined in different localities. Some doubt is expressed regarding the completeness of the canal theory of the general circulation of the atmosphere between the equator and the poles, but the scheme of Ferrel is approved in general. The vertical convectional theory of the origin of cyclones is vigorously rejected and the horizontal convection theory is favored. The action of countercurrents of air is distinctly illustrated in the formation of tornadoes and waterspouts, tropical hurricanes and extratropical cyclones; the origin and direction of two independent component streams of air are plainly described. The general equation of equilibrium in terms of gradient, deflecting and centrifugal forces is clearly deduced and its meaning carefully illustrated. A good historical description is given of the first weather charts and the earliest synoptic daily maps. The deflection angle seems to be preferred to the inclination angle for the purpose of analyzing the relation of the wind direction to the gradient. It is shown that V-shaped depressions are characteristic of the Southern Hemisphere, with counter winds on each side, while cyclonic gyrations are but further developments of the same phenomenon, and are more commonly found in the Northern Hemisphere. Summer hot waves are explained as stagnant masses of air, in which heat gradually accumulates at the ground and then increases upward to great heights. The foehn wind effect is due to dynamic heating of the air descending from the crest of a mountain range to the valley. The bora is due to masses of air of different temperatures lying close together without mixing, and then pushing forward as a whole, as over a coast line. The types of American weather have not been sufficiently developed and published. A strong and even abnormal vertical temperature gradient accompanies the formation of thunderstorms, which are attended by an inversion of the overlying strata. The squall in thunderstorms is a horizontal roll at the front. The formation of hail seems to be due to a tornado tube or vertical whirl in the upper strata of the cloud, and Ferrel's orbit theory for the formation of the successive layers of ice and snow in the hailstone is regarded with favor. The secular variation of nearly all the meteorological elements in the 11-year and the 35-year solar periods is admitted, but these researches are not yet in a conclusive or satisfactory state of development. The stratification of the atmosphere with currents of different temperatures, especially where abnormally cold air overlays excessively warm strata, and the consequences of such unstable conditions of equilibrium are well depicted. The theory of the cause of the atmospheric electric potential fall that seems most promising is the ionization theory of gases which is briefly described.

Finally, I shall venture to remark that it is likely that further consideration, and the accumulation of suitable observations, will probably tend to modify Dr. Hann's views regarding the canal theory of the general circulation, and especially as regards Ferrel's idea of the westward flow at the north pole, and the triple stratification of currents on the polar side of the trade wind zones; the cause of the double diurnal barometric wave is still open to discussion; also there are very serious objections against accepting Ferrel's theory of the orbital motion of hailstones in the neighborhood of a tornado tube in the upper strata of a thunderstorm cloud. On pages 272, 273, 275 it is stated that in the Weather Bureau observations of 1896–97 certain cloud heights were measured by nephoscopes. The fact is that all the cloud heights were determined by the theodolite, and then certain mean heights were adopted to carry forward the discussion of the nephoscope observations.

Dr. Hann deserves the thanks and will receive the congratulations of all meteorologists for his able, useful, and satisfactory work. It is a book that should be translated into English and placed in the libraries of all colleges, in library reference rooms, and in the hands of those students who intend to take up the subject seriously. It will give a strong impetus to sound learning in this branch of science, and it is a worthy companion to Dr. Hann's well known "Klimatologie."

RECENT PAPERS BEARING ON METEOROLOGY.

W. F. R. PHILLIPS, in charge of Library, etc.

The subjoined titles have been selected from the contents of the periodicals and serials recently received in the library of the Weather Bureau. The titles selected are of papers or other communications bearing on meteorology or cognate branches of science. This is not a complete index of the meteorological contents of all the journals from which it has been compiled; it shows only the articles that appear to the compiler likely to be of particular interest in connection with the work of the Weather Bureau:

Meteorologische Zeitschrift. Wien. Band 19.

Paulsen, A. Vorläufige Mittheilungen über einige Arbeiten der Dänischen Expedition in Utsjoki. Pp. 276–279.

Ekholm, Nils. Ueber die Höhe der homogenen Atmosphäre und die Masse der Atmosphäre. Pp. 249–260.

—— Täglicher Gang des Luftdruckes und der Temperatur zu San José de Costa Rica. Pp. 273–274.

Krebs, W. Neue Sonnenringbeobachtung. P. 275.

—— Klima von Potsdam. Pp. 275–276.

Exner, Felix M. Ueber den Gleichgewichtszustand eines schweren Gases. Pp. 278–279.

—— Das Weather Bureau. P. 279.

—— Physiologische Wirkung des verdünnten Luftdrucks. Pp. 279–280.

—— Verdunstung zu Camden Square, London. P. 281.

—— Grosser Regenfall in England am 12 Juli 1900. Pp. 280–281.

—— Zur Meteorologischen Optik. P. 282.

Benndorf, H. Ueber ein Mechanisch registrirendes Elektrometer für luftelektrische Messungen. Pp. 282–283.

Birkeland, Kr. Norwegische Erdmagnetische Expedition 1902–1903. Pp. 283–284.

—— Das Darmer'sche Quecksilberbarometer. Pp. 284–285.

—— Klima von Pemba, Ostafrika. P. 285.

—— Galvanometrische Beobachtung ferner Gewitter. Pp. 285–286.

—— Meteorologische Beobachtungen im (sog.) arktischen Nordamerika. P. 286.

—— Gewitter und Mondphasen. P. 289.

Schwarz, L. St. Elmsfeuer auf der Schneekoppe. Pp. 289–290.

Weitlaner, Franz. Einzelne Sonnenuntergangs-und Dämmerungsformen in subtropischen und tropischen Gebieten. Pp. 290–292.

—— Deutsche Meteorologische Gesellschaft. Jahresbericht und Rechnungsablage für 1901. Pp. 270–271.

Hann, Julius. W. v. Bezold: Ueber klimatologische Mittelwerthe für ganze Breitekreise. Pp. 260–263.

Hann, Julius Teisserenc de Bort über die Temperaturabnahme mit der Höhe. Pp. 272–273.

Hann, Julius. Anschliessende Bemerkungen über die Mittelwerthe der meteorologischen Elemente für die Ganze Erdoberfläche. Pp. 263–269.

Hann, Julius. Die Temperatur des Mai in Wien. Pp. 271–272.

Hann, Julius. Interdiurne Temperaturveränderlichkeit in Mexiko. P. 281.

—— Maikälte in England. P. 272.
—— Tintenregen in Paris. P. 272.
Hann, Julius. Resultate der meteorologischen Beobachtungen am Observatorium zu Rousdon (England) 1884–1900. P. 286–288.

Comptes Rendus de l'Académie des Sciences. Paris. Tome 134.
Eginitis, D. Sur une perturbation magnétique, observée à Athènes le 8 mai 1902. Pp. 1425–1426.

Comptes Rendus de l'Académie des Sciences. Paris. Tome 135.
Viguier, C. Influence de la température sur le développement parthénogénétique. Pp. 60–62.

Annalen der Hydrographie und Maritimen Meteorologie. Berlin. 1902.
Reinicke. Temperaturwerthe und Niederschlagsmengen zu Neufahrwasser in den Jahren 1876 bis 1900. Pp. 334–336.
Hr. Der Bora-sturm im nördlichen Adriatischen Meere am 31. Januar und 1 Februar 1902. Pp. 327–331.

L'Aérophile. Paris. 10me Année.
Canovetti, C. Études sur la résistance de l'air. Pp. 140–144.
Grégoire, Pierre J. Aviateur à ailes battantes. Pp. 134–140.

Ciel et Terre. Bruxelles. 22me Année.
Very, F. W. Un cycle cosmique. Pp. 216–224.
P., W. L'éruption de la montagne Pelée, à la Martinique. Pp. 207–209.

Archives des Sciences Physiques et Naturelles. Genève. 107me année. 4me Période. Tome 13.
Gautier, R. Observations météorologiques faites aux fortifications de Saint-Maurice pendant l'année 1901. Pp. 581–595.

Annuaire de la Société Météorologique de France. Paris. 50me Année.
Poincaré, A. Combinaison des effets barométriques de la révolution synodique et de la rotation terrestre sur l'ensemble du globe. Pp. 96–102.

Journal New York Botanical Garden. New York. Vol. 3.
MacDougal, D. T. Effect of Lightning on Trees. Pp. 131–135.
MacDougal, D. T. The Temperature of the Soil. Pp. 125–131.

Das Wetter. Berlin. 19 Jahrgang.
Polis, P. Wetterdienst am Meteorologischen Observatorium zu Aachen. Pp. 141–143.
Assmann, Richard. Die örtlichen Bedingungen für die Anlage einer Drachenstation. Pp. 121–130.
Grohmann, —. Die klimatischen Verhältnisse des Königreiches Sachsen in ihrer Abhängigkeit von Luftdruck und Windursprung. Pp. 130–140.

Zeitschrift für Gewasserkunde. Leipzig. 5 Band.
Gravelius, H. Zur Kenntniss der Seiches des Eriesees. Pp. 43–51.
Halbfass, Wilhelm. Stehende Seespiegelschwankungen (Seiches) im Madüsee in Pommern. Pp. 15–38.

Geographical Journal. London. Vol. 20.
André, E. The Volcanic Eruption at St. Vincent. Pp. 60–68.
Dickson, H. N. The Eruptions in Martinique and St. Vincent. Pp. 49–60.
—— The Atmosphere in the Neighborhood of Vesuvius. [Note on paper by G. Melander.] P. 100.

Electrical World and Engineer. New York. Vol. 40.
Gore, J. W. Wireless Telegraphy, an Electrostatic Effect? Pp. 51–52.
Marconi, —. Wireless Telegraphy. Pp. 49–51.

Scottish Geographical Magazine. Edinburg. Vol. 18.
—— The Climate of Edinburg. Pp. 349–353.

Science. New York. Vol. 15.
Baskerville, Charles, and Weller, H. R. Black Rain in North Carolina. P. 1034.

Science. New York. Vol. 16.
Barus, C. On a Method of Hygrometry. Pp. 33–34.
Ward, R. DeC. Iridescent Clouds. Pp. 32–33.

Memoria de Societa "Antonio Alzate." Mexico. Tome 16.
Moreno y Anda, M. La meteorologia y las predicciones del calendario de Galvin. Pp. 229–237.
Puga, Guillermo B. Consideraciones sobre la distribucion general de las lluvias y en particular en la Republica Mexicana. Pp. 137–156.

Gaea. Leipzig. 38 Jahrgang.
—— Die vulkanischen Eruptionen auf Martinique und St. Vincent. Pp. 449–466.
—— **M. u. S.** Einfluss von Schiessübungen auf die Gewitterthätigkeit. Pp. 466–468.
—— Die Elektrizitätszerstreuung in ultraviolett durchstrahlter Luft. Pp. 468–470.
—— Der Südwestmonsun im Atlantischen Ocean. Pp. 470–473.
—— Die Ergebnisse der Niederschlagsbeobachtungen in Preussen 1897 und 1898. Pp. 473–477.
Witte, E. Zur Theorie der Stromkabbelungen. Pp. 484–487.
—— Ueber die Meteorologie des Aequators. [Note on article by J. Hann.] Pp. 502–503.

Scientific American. New York. Vol. 87.
—— Photography of Sound Waves. P. 34.
—— A Peculiar Lightning-Shattered Tree. P. 41.

Illustrirte Aeronautische Mittheilungen. Heft 3. 1902.
Martienssen, O. Theoretische Grundlage für die Construction eines Schraubenfliegers. Pp. 125–133.
Kutta, W. M. Auftriebskräfte in strömenden Flüssigkeiten. Pp. 133–135.

Bulletin of the American Geographical Society. New York. Vol. 34.
Ward, Robert DeC. The Agricultural Possibilities of Alaska. [Note on The Possibilities of Alaska, and Agriculture in Alaska, in National Geographical Magazine.] Pp. 239–240.
Ward, Robert DeC. The Mexican Belt of Calms. [Note of James Page on the Pilot Chart of the North Pacific Ocean for April.] Pp. 241–242.
Ward, Robert DeC. Loss of Life in the United States by Lightning. [Notes on Bulletin No. 30, Weather Bureau, Loss of Life in the United States by Lightninng.] Pp. 238–239.
Ward, Robert DeC. Climate of Western Australia. [Notes on The Climate of Western Australia issued from Perth (W. A.) Observatory.] Pp. 240–241.
Ward, Robert DeC. Some Physiological Effects of Sunshine and Shade. [Abstract of Quelques Mots sur le Groupement de la Population du Valais, by M. Lugeon (Etrennes Helvétiques pour 1902)]. P. 241.

Philosophical Magazine. London. 6th series. Vol. 4.
Trowbridge, John. On Spectra arising from the Dissociation of Water Vapour and the Presence of Dark Lines in Gaseous Spectra. Pp. 156–161.
Barus, C. The Sizes of the Water Particles producing the Coronal and the Axial Colours of Cloudy Condensation. Pp. 24–29.

Aeronautical Journal. London. Vol. 6.
—— The Variation of Temperature with Height. [Abstract of article in Nature by N. Shaw.] P. 50.
—— The Measurement of Electricity in the Air from Balloons. Pp. 47–48.
—— The Ballon-Sondes Experiments. P. 48.
—— The Hargrave Flying Machine. Pp. 48–49.
—— The Physiology of Ascents. P. 47.
Bacon, J. M. Scientific Observations at High Altitudes. Pp. 40–43.
—— The Recent High Balloon Ascent of Dr. Süring and Dr. Berson. Pp. 46–47.

Nature. London. Vol. 66.
Chree, C. Arctic Magnetic Observations. Pp. 227–228.
Porter, T. C. The Halos of May 1, 8, and 22. P. 223.
Clark, J. Edmund. The Coloured Sunsets. P. 223.
Lockyer, William J. S. The Coloured Sunsets. Pp. 222–223.
Krohn, F. W. T. Remarkable Sunsets at Madeira. P. 199.
Sutton, J. R. Cold Weather in South Africa. P. 247.
Lockyer, William J. S. and Norman (Sir). A Short Period of Solar and Meteorological Changes. Pp. 248–249.
—— Apparent Deformation of the Sun's Disc near the Horizon. P. 259.
—— Oceanographical Investigations in South African waters. P. 260.

Bolétin Sociedad Geográfica. Lima. Año 11. Tomo 11.
Valdizan, Dario. Observaciones termométricas tomadas en el campamento "El Mirador," provincia de Chincha, de mayo á julio de 1901. Pp. 417–420.
—— Temperatura diaria tomada á la sombra en la Hacienda Chiquitoy (valle de Chicama), en los años de 1900 y 1901. Pp. 415–417.
Jones, H. Hope. Observaciones tomadas en San Ignacio, Cailloma, de agosto á diciembre de 1901. Pp. 412–414.
Aguayo, Francisco B. Disertacion sobre la temperatura de Lima. Pp. 367–393.

Annalen der Physik. Leipzig. 4 ser. Band 8.
Stark, J. Einfluss der Temperatur auf die Ionisirung durch Ionenstoss. Pp. 829–841.
Stark, J. Der Ionenstoss als Ionisator in neueren Versuchen. Pp. 815–828.

Symons's Meteorological Magazine. London. Vol. 37.
Ellis, W. The Moon and Rainfall. [Note on Mr. MacDowall's communication to Symons's Met. Mag. London. November, 1901.] Pp. 85–87.

Journal de Physique. Paris. Tome 1.
Sagnac, G. Chr. Jensen. Kurzer Ueberblick über die Thatsachen und Theorien auf dem Gebiete der atmosphärischen Polarisation (Court aperçu sur les faits et théories relatifs à la polarisation atmosphérique). Pp. 448–449.

Proceedings of the Royal Society of London. London. Vol. 70.
Cullom, J. E. Report of Absolute Magnetic Observations at the Valencia Observatory (Cahirciveen, County Kerry), 1899, 1900 and 1901. P. 246–249.

Journal of the Franklin Institute. Philadelphia.
Keller, H. F. The Gases of the Atmosphere. Pp. 47–57,

Popular Science Monthly. New York. Vol. 61.
Jaggar, Thomas Augustus. Field Notes of a Geologist in Martinique and St. Vincent. Pp. 352–368.

Memorie della Societa degli Spettroscopisti Italiani. Catania. Vol. 31.
Boccara, Vittorio E. Sulle Variazioni Diurne Della Rifrazione Atmosferica. (Secondo Contributo). Pp. 89–97.

Physical Review. Lancaster. Vol. 15.

Knipp, Charles T. Method of Maintaining Intermediate Temperatures. P. 125-126.

American Journal of Science. New Haven. 4th ser. Vol. 14.

Trowbridge, J. Spectra Arising from the Dissociation of Water Vapor and the Presence of Dark Lines in these Spectra. Pp. 1-7.

GROUND TEMPERATURE OBSERVATIONS AT ST. IGNATIUS COLLEGE, CLEVELAND, OHIO.

By DR. LYMAN J. BRIGGS, Bureau of Soils.

In the report of the Meteorological Observatory of St. Ignatius College, Cleveland, Ohio, 1900–1901, Rev. F. L. Odenbach, S. J., publishes a series of observations on ground temperatures made at a depth of 4 feet. The observations cover a period from 1897 to 1901. The monthly and yearly mean for each year during this period is given, and the daily temperatures during the months of February, May, and August, 1900, are also published. The following excerpt from the report of the observatory gives the method of making the determinations:

> The data subjoined were gathered from a thermometer placed 4 feet below the surface of the ground. Great care was taken to insulate it from solar radiation and atmospheric temperature. For this purpose a 2-inch steel pipe was sunk into the ground, the lower end reaching 4 feet below the surface. The top end projects through the bottom of, and 4 inches into, an earthenware jar. This projecting part within the jar is capped with a movable cover made of 2.5-inch steel pipe. The jar, in turn, is covered with a lid of earthenware and the whole, which stands even with the ground surface, is covered with a wooden drum. The thermometer, which rests at the bottom of the 4-foot shaft, may be pulled up by a chain after the three covers have been removed. It is encased in a wooden tube, exposing only the grading of the mercury column; while its bulb has been insulated by a mixture of asbestos and carbonate of magnesium, held around it by a perforated brass cup. With all these precautional appliances, we are certain of getting a real ground temperature. The circulation within the tube might seem to create some difficulty, but it was supposed that the warmer air toward the surface would not descend, but that it would lose its temperature where it was, by the conductivity of the steel pipe which extended downward into colder regions. The insulation of the bulb is so perfect that it may be exposed to the direct rays of the sun for almost half a minute before it shows signs of rising; it may therefore be read with leisure and without fear of its having been influenced by the temperature existing above ground. Because it is not subject to diurnal variations, it has been read at 8 a. m., seventy-fifth meridian time, daily; this being the time at which all other observations are taken.

We regret that we can not agree with Odenbach in his conclusion that his observations represent the true ground temperature at a depth of 4 feet. It will be noted that a 2-inch steel pipe extends from near the surface of the ground to a depth of 4 feet, and that the thermometer with which the observations were made was placed inside of this pipe. The bulb of the thermometer was not embeded in the soil, but was simply suspended at the base of the shaft, or with its asbestos insolation resting upon the bottom of the shaft. The temperature recorded therefore was not the temperature of the soil, but rather that of the air in the bottom of the shaft. No provision whatever was apparently made to prevent air-convection currents in the steel tube, so that the thermometer really records the temperature of the convection currents at the bottom of the shaft. During the summer months when the temperature at a depth of 4 feet is lower than the temperature nearer the surface, the error introduced from this source would probably not be great, but during the winter months when the surface stratum of soil is cooler, the cooler air in the upper portion of the tube would continually settle towards the bottom of the shaft, and the thermometer would record temperatures lower than the actual temperature of the soil at a depth of 4 feet.

Another feature leading to erroneous results is the steel tube extending from the bottom to the top of the shaft. Steel being so much better a conductor than the soil, would, during the warmer months, readily conduct the heat down from the surface stratum and so raise the temperature of the lower portion of the shaft. In winter also, the temperature of the lower part of the shaft would by this means be reduced below the true temperature of the soil at that depth.

In the opinion of the reviewer a far more satisfactory and reliable method of investigating ground temperatures at a considerable depth below the surface is to be found in some form of electrical thermometer. An insulated coil can be buried at the desired depth and allowed to remain undisturbed throughout the whole period of investigation of temperature; the presence of all heat-conducting material other than the soil is limited to the two small wires forming the terminals of the resistance coil. This method is employed in the temperature observations now being carried on at the Radcliffe Observatory,[1] Oxford, where platinum resistance thermometers of the well known Callendar and Griffiths pattern are used. Attention should also be called to the method of reducing the observations at Oxford, first employed by Thomson,[2] which gives not only the temperature but important data regarding the thermal conductivity of the soil as well. The observations are first grouped into monthly means, and harmonic expressions are then deduced which will represent the readings of each thermometer throughout the year. From each wave as observed at any pair of thermometers two determinations of the thermal conductivity of the gravel may be obtained, one from the diminution of the amplitude of the wave and the other from the retardation of phase.

UNSEASONABLE WEATHER IN THE UNITED STATES.

By Prof. E. B. GARRIOTT, Weather Bureau, dated July 31, 1902.

The cause of unseasonable weather is not demonstrable. Neither is it possible in all cases to determine which of the general atmospheric conditions that are associated with unseasonable weather partake of the nature of cause and which of effect.

It has been observed that summer periods of low temperature are associated with barometric pressure below the normal and abundant rainfall, and that summer periods of excessive heat are associated with barometric pressure about or above the normal and a marked deficiency in rainfall. It has also been observed that winter periods of excessive cold are associated with barometric pressure above the normal and little or no precipitation, and that periods of high temperature in winter are associated with barometric pressure below the normal and rain or snow. It has been observed further that the general atmospheric conditions referred to are associated with areas of high and low barometric pressure that traverse the United States. In summer the atmosphere over regions subjected to unusual cold and abnormally heavy rainfall is dominated by areas of low barometric pressure, or general storms, that follow unusual tracks for the season, and the atmosphere over regions subjected to unusual heat is undisturbed by the passage of general storms, and is dominated by an extensive and almost stationary area of high barometric pressure. In winter periods of excessive cold are experienced in connection with areas of high barometric pressure of great magnitude that advance from the British Northwest Territory, and also in connection with general storms that follow abnormal southerly paths, and periods of unusually warm weather occur in connection with a succession of general storms that pursue abnormal northerly paths.

A study of the daily meteorological charts of the Northern Hemisphere shows that the general atmospheric conditions over the United States that are associated with unseasonable weather in any part of the country are, in turn, associated with atmospheric conditions that obtain over at least a great part of the Northern Hemisphere. The international charts

[1] Proceedings Royal Society, 67, p. 218, 1900.

[2] Transactions Royal Society, Edinburg, 22, p. 409, 1861.